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Deliberate charcoal consumption by an introduced parrot, eastern rosella (*Platycercus eximius*), in New Zealand

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Many animals intentionally ingest substances that are not considered as food. Most commonly documented and studied is the consumption of soil (including rock fragments, clays, and salts), known as geophagy (Diamond et al. 1999; Panichev *et al.* 2013). Akin to geophagy, though not strictly falling under its definition, is the consumption of charcoal. While geophagy has been recorded for a wide diversity of animal taxa, including insects, bats, birds, reptiles, ungulates, lagomorphs, and primates including humans (Kreulen 1985; Diamond *et al.* 1999; Krishnamani & Mahaney 2000; Rea *et al.* 2013; Rea 2017; Brightsmith *et al.* 2018), reported deliberate consumption of charcoal is limited to humans, Zanzibar red colobus monkeys (*Procolobus kirkii*), 4 Australian bird species (Baldwin 1965), and unpublished reports for deer, elk, other ungulates, and domestic dogs (Cooney 1995; Struhsaker *et al.* 1997). The best known example of avian geophagy occurs among macaws and other parrots (Psittacidae) of the Amazon basin, where birds may spend more than 2 hours travelling many kilometres to clay licks (Brightsmith *et al.* 2008). This substantial investment in the behaviour suggests it is driven by strong physiological requirements (Brightsmith *et al.* 2008). Here I report an observation of deliberate consumption of a 'non-food' substance in a pair of eastern rosellas (*Platycercus eximius*; Fig. 1a) – an invasive species of broad-tailed parrot introduced to New Zealand from Australia in the early 20th century (Galbraith 2010).

At 1550 h on 12 November 2016, I observed a pair of eastern rosellas (hereafter rosellas) perched in a tōtara (*Podocarpus totara*) on a private property near Ngunguru, Northland, New Zealand (35°36′06.0″S, 174°28′55.0″E). The male flew from the tōtara to an old railway sleeper (a flight distance of approx. 8 m) – one of a number of railway sleepers running along the ground parallel to the driveway of the property. He walked along the sleeper to a section which had been burnt out, leaving a concave crater (Fig. 1b). He hopped into this burnt-out crater and began eating, taking bites of the black charcoal within. As he did so he called softly to his mate ("wit wit" contact calls) who was perched in the tōtara tree. He took 7–8 bites before the female came down to join him; she also started eating the charcoal. The contact calls from the male appeared to encourage the female down to the sleeper. Both ate another 5–6 bites together, before the male hopped off the sleeper and moved down the driveway approx. 1 m, before

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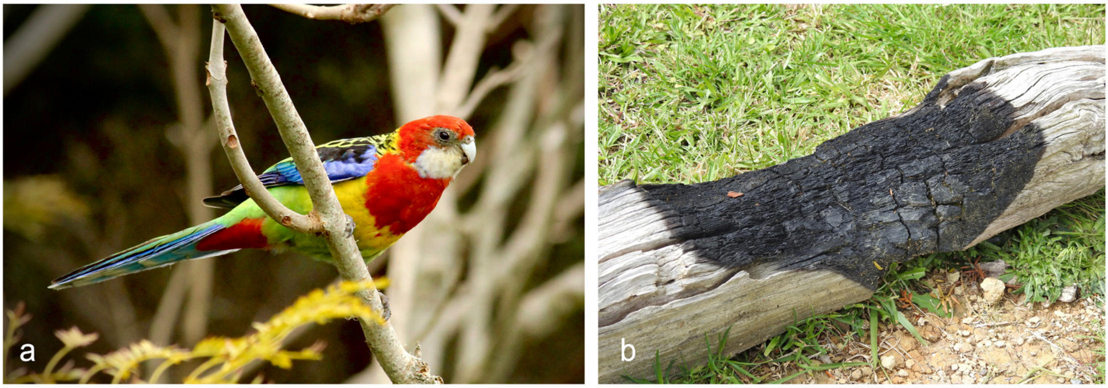

Fig. 1. Photographs of a) an eastern rosella (*Platycercus eximius*); b) a burnt section of timber from which a pair of eastern rosellas were observed feeding directly on charcoal (Photos: J. Galbraith).

flying back up to the tōtara. The female continued eating charcoal for a short time, consuming another 5–6 bites. In total, the male consumed roughly 15 bites of charcoal, and the female roughly 12 bites. They each were on the sleeper feeding for 3–4 minutes.

Despite spending many field hours observing this species for previous studies (Galbraith 2010; Galbraith *et al.* 2011; Galbraith *et al.* 2014), I had not before witnessed eastern rosellas intentionally consuming non-food substances during foraging. There is no mention of any non-food items being eaten by rosellas in the three studies of rosella diet in New Zealand (Wright & Clout 2001; Woon *et al.* 2002; Fraser 2008), however, previous dietary studies conducted in Australia have recorded individuals consuming 'grit' (Higgins 1999). There are also sporadic records from Australia of charcoal found in the crop contents of eastern rosellas and other parrot species (Long 1984; Jones 1987; Forshaw 1989). These records, though, do not demonstrate intentional selection of this substance during foraging; I could find no documented field observations of parrots deliberately ingesting charcoal. A wider literature search for geophagy and charcoal consumption in New Zealand avifauna (via Web of Science, Scopus, and Google Scholar) produced no New Zealand-specific studies. The complete dearth of results indicates that the observation made in this short note is a significant record for New Zealand; to the best of my knowledge it is the first published record of deliberate avian charcoal consumption here. It is possible, though, that other records exist buried within historical natural history accounts or more general dietary studies, which are not digitally searchable or refer to this behaviour by other terms. I suspect that geophagy involving the ingestion of grit has been observed among New Zealand avifauna on many occasions, but perhaps is seldom documented in publications. Certainly, though, observations globally of wild animals deliberately consuming charcoal are much less common, making this an important record internationally as well as for New Zealand.

Without further study we can only speculate as to why this pair of eastern rosellas were intentionally consuming a non-food substance, bearing in mind that even within the best-studied avian example of geophagy (western Amazonian parrots) the drivers are still debated (Brightsmith *et al.* 2018). One of the most widely known explanations for geophagy involving larger particulates (e.g. grit, sand, gravel, rock fragments) is that these are ingested as a mechanical aid to enhance digestive grinding (Gilardi *et al.* 1999). Typically, when ornithologists refer to grit consumption, it is this enhanced grinding function they associate with the behaviour (Diamond *et al.* 1999). Parrots, however, do not necessarily need to increase their internal food grinding capabilities as their mechanical food processing is primarily done by their strong bill and muscular tongue before being swallowed (Toft & Wright 2015). Instead, geophagy in parrots is most often discussed in relation to 2 hypotheses: 1) that geophagy supplements essential minerals otherwise lacking in the diet, for example calcium (Reynolds & Perrins 2010) and sodium (Burger & Gochfeld 2003; Brightsmith *et al.* 2018); and 2) that geophagy confers protection from dietary toxins (Gilardi *et al.* 1999; Burger & Gochfeld 2003; Mee *et al.* 2005). These 2 theories are not mutually exclusive – both may drive geophagy under different conditions. Thus, either is a possible explanation for the consumption of 'grit' in previous observations of eastern rosella in Australia (Higgins 1999).

Charcoal consumption, however, is usually associated with the second hypothesis. Charcoals are unlikely to be a source of dietary minerals due to extreme inertness, but they are known to adsorb and immobilise potentially toxic compounds like phenols particularly well, while allowing continued digestion and absorption of proteins (Struhsaker *et al.* 1997). For generalist herbivores like rosellas, meeting nutritional requirements from vegetation is a trade-off against the toxic secondary compounds produced by plants as a defence against herbivory. Despite evidence to suggest that parrots have the ability to avoid foods high in toxins as part of foraging strategies, parrot diets have still been found to contain measureable toxin levels (Gilardi & Toft 2012; Péron & Grosset 2014). Certainly, rosellas in New Zealand forage on a wide variety of native and introduced plants, many of which are known to contain secondary compounds that may be toxic to vertebrates, for example karaka (*Corynocarpus laevigatus*), ngaio (*Myoporum laetum*), willow (*Salix* spp.), poplar (*Populus* spp.), eucalypts (*Eucalyptus* spp.) (Wright & Clout 2001; Woon *et al.* 2002; Fraser 2008), and common oak (*Quercus robur*) (*pers. obs.*). Consequently, we may hypothesize that the observed rosella pair benefitted from the toxin-adsorbing properties of the charcoal they consumed. The use of charcoal appears commonly in captive avian management and health for this reason (De Francisco *et al.* 2003; Heuser 2003), and can be purchased off-the-shelf for companion animals, often marketed as a 'digestive aid' (e.g. Charcoal "For all birds", Hagen, Montreal, Canada).

Interestingly, charcoal often turns up in palaeoecological studies of coprolite composition, including, for example, in coprolites of the endemic parrot the kākāpō (*Strigops habroptilus*), another generalist herbivore (Horrocks *et al.* 2008). Frequently discussed in terms of past fire events, ingestion of charcoal in this context is typically assumed to be unintentional. An interesting alternative perspective would be to consider the possibility that these records may also document deliberate charcoal eating. I encourage other researchers to document and report any observations (historical as well as future) of charcoal consumption, or geophagy, among the wider New Zealand avifauna, so that we might better understand the prevalence of this behaviour and discuss what importance it may have in this region for avian herbivores in particular.

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